DiffuseReflections

The Newsletter for Progressive Acoustics Research

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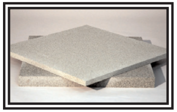


Reapor™

RPG is proud to announce the Next Generation of recycled, non-combustible, fiber-free, sintered glass absorbor, offering indoor and outdoor application.

IN THIS ISSUE

"As President of RPG, I am proud that we remain the industry's leading acoustical Innovator. It has now been over twenty years, since we introduced commercial diffusors. As a result of our success, we have spawned several Imitators and Irritators. Our recent patent on the next generation of diffusors, based on Aperiodic Modulation (AM), raises the bar once again."

For up to the minute information, we invite you to visit RPG's acclaimed web site: http://www.rpginc.com.

DIFFUSE NEWS

Dr. Peter D'Antonio
President and CEO

Everything Acoustic!

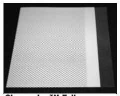
In every industry, there are Innovators, Imitators and Irritators. Innovators set the bar. Imitators follow the lead of the Innovator, sometimes improving the product, as a result of hindsight. Imitators may evolve into Competitors, which is good for the industry. Or, if they merely counterfeit the product, they become Irritators, low bidding to the contractor, without proof of performance testing. As President of RPG, I am proud that we remain the industry's leading acoustical Innovator. It has now been over twenty years, since we introduced commercial diffusors. As a result of our success, we have spawned several Imitators and Irritators. Our recent patent on the next generation of diffusors, based on Aperiodic Modulation (AM), raises the bar once again. We encourage you to evaluate this new technology at www.rpginc.com/am. ***This is only the beginning***............

CONTINUALLY EVOLVING......

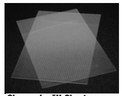
THE FUTURE IS CLEAR!

The need for transparent/translucent, fire-safe absorbers that do not contain any fibrous materials is growing, due to demands from LEED, life safety regulations and designs requiring natural or artificial lighting. To address these needs, RPG is now offering a broad range of fiber-free, transparent/translucent absorbers called Clearsorber™. Each product in the range owes its absorption to sub-millimeter diameter microperforations, comparable to the boundary layer thickness, spaced 2-5 mm apart. When longitudinal sound waves oscillate through these microperforations, significant viscous boundary layer losses occur in the perforations, as long as there is an air space behind the absorber. Microperforations eliminate the need for porous absorption in the cavity between the Clearsorber™ and the vision glass. The deeper the air cavity, the lower the resonant frequency.

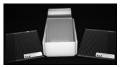
These are Helmholtz devices, but without the traditional porous cavity absorption. The device is like a double glazing unit, with the first pane being microperforated. The range consists of 0.1 mm Clearsorber™ Foil, 1 mm Clearsorber™ Sheet, 2-15 mm Clearsorber™ Panel and 19-35 mm Clearsorber™ Honeycomb composite. Clearsorber™ is the perfect solution for treating troublesome low to mid frequency noise and reverberance in spaces, such as atria, lobbies, prefunction spaces, museums, botanical gardens, convention centers, offices, worship spaces, etc. Please visit www.rpginc.com for details.



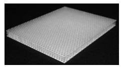
Clearsorber™ Foil



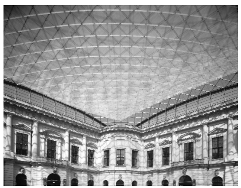
Clearsorber™ Sheet



Clearsorber™ Panel



Clearsorber™ Honeycomb



Research & Development

BASS MANAGEMENT

Low frequency problems in acoustically small rooms, such as conference and teleconference rooms, distance learning rooms, classrooms, lecture halls, offices, recording and broadcast studios, music and choral rehearsal rooms, individual practice rooms, individual and open-plan offices, call centers and other communication areas are generated by noise intrusion from outside the room or sources within. External sources include low frequency transmission through walls, ceiling and floor (with levels 20 dB higher at 100 Hz than at 1000 Hz), HVAC breakout and duct noise, electrical hum and other mechanical noise. Internal sources include reproduced sound, live sound or speech. The male voice peaks at about 500 Hz and is 8 dB down at 100 Hz. This low frequency interference can cause problems with intelligibility, due to low frequency masking, speech privacy and sound clarity and quality. In addition, the room's natural resonances in the form of room modes can amplify these low frequency sources, by as much as 20 dB. The widespread use of mid and high frequency absorption in the form of acoustical ceiling tile, fabric wrapped panels, carpeting, curtains, etc. can do little to control the low frequency effects occurring below roughly 250 Hz, and especially in the modal frequency range that we are calling the Forgotten Octave between 125 and 63 Hz and below.

Solution

In DR V10I, we introduced the Modex Plate and Modex Broadband, which have effective absorption down to 50 Hz, requiring only 4 inches of depth. These new modal absorbers provide a solution to minimizing low frequency interference in rooms. The absorption occurs via three mechanisms. The first is pistonic action of the plate against the porous backing layer acting as a spring, according to Eq. 1, where, c_d (m/s) is the speed of sound in the porous absorber, ρ_d and ρ_l are the density in

$$f_R = \frac{c_d}{2\pi}\sqrt{\frac{\rho_d}{\rho_t t d}}(Hz) \qquad (1)$$

Kg/m³ of the absorber and the plate, respectively. t(m) and d(m) are the thickness of the plate and absorber, respectively. The second mechanism is due to the free bending vibrations of the thin plate, according to Eq. 2.

$$f_{n,m} = \frac{\pi}{2}t\sqrt{\frac{E}{12(1-\mu^2)\rho_t}}\left[\left(\frac{n}{l_n}\right)^2 + \left(\frac{m}{l_m}\right)^2\right](Hz) \qquad (2)$$

where E (N/m²) is the Young's modulus and μ is the Poisson's ratio. l_n and l_m (m) are the plate dimensions and n and m are integers, representing the order of the mode. The plate undergoes elastic deformation in reaction to incident sound, with energy losses resulting from friction with the porous backing. There are many low frequency plate modes that can couple with room modes to attenuate them. For t=2 mm, $\mu = 0.5$, ln = 1 m, l_m = 1.5 m, the lowest mode is $f_{1,1}$ = 6.6 Hz. The third mechanism is diffraction around the metal plate into the porous backing layer to increase the bandwidth to roughly 250 Hz. This upper end absorption can be controlled by the open area of the side panels.

Proof of Performance

Perhaps one of the reasons why modal absorbers have not been developed until now may be the lack of measurement accuracy below 100 Hz. There are two standardized methods for the measurement of sound absorption, the reverberation room method (ISO 354) and the impedance tube (ISO 10534). The rev room method is based on a diffuse sound field in the room. For rooms with a volume of 200 m3 or more, the lower frequency limit lies between 100 and 125 Hz. The impedance tube method measures the impedance and absorption coefficient for normal incidence, with its low frequency limit determined by the longitudinal dimensions of the tube. The results of both methods are very sensitive to sample mounting conditions, especially at low frequency.

The sound field at low frequencies in a room is determined by a small number of eigenfrequencies. The appropriate measurement technique is determined by the number of third octave modes. If the number of eigenfrequencies is greater than 20, then the standard ISO 354 method is applied. If the number of eigenfrequencies is between 5 and 20, then the samples are placed in the corners and the ISO 354 standard formula is used. If the number of third-octave eigenfrequencies is 5 or less, each eigenfrequency must be excited individually with a sine wave signal. The decay times at a particular frequency without and with the test object in the room are measured. From these the *effective* absorption coefficient at this frequency is calculated according to Eq. 3, where

$$\alpha_{eff} = 55.3\left(\frac{V}{Sc}\right)\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \qquad (3)$$

T_1 and T_2 are the decay times without and with the sample, V is the volume, S is the surface area of test objects and c is the speed of sound. The effective absorption is sensitive to room dimensions and placement, so experience is required. To isolate the beating effects of neighboring eigenfrequencies for the first five modes, three measurements are made, where the samples are placed in each of the axial directions. In addition, up to eight microphones are positioned at specific positions, where the neighboring eigenfrequencies have a sound pressure null. This measurement provides a powerful in-room measurement. Measurements in a new very large impedance tube are also being investigated.

In the next issue, we will discuss the physical and psychoacoustical benefits, derived by application of modal absorbers with extension to 50 Hz, in offices, conference rooms, recording/broadcast studios, music/choral rehearsal rooms and classrooms and lecture halls.